The midclavicular line: a wandering landmark

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Although the midclavicular line (MCL) is the usual reference point for clinical assessment of liver size and localization of the cardiac apex beat, we found substantial interobserver variation in locating the MCL. The distance from the midline to the MCL as estimated by 20 clinicians in three subjects varied by up to 10 cm. More variation was found for estimates in the obese subject than for those in the two subjects of normal build (p = 0.004). No difference in variation was found between consultants and house staff. The limitations of the MCL as a reference point are discussed in light of these findings.

Il est traditionnel de mesurer la hauteur du foie et de déterminer l'emplacement du choc de la pointe cardiaque par rapport à la ligne médio-claviculaire (LMC). Mais nous trouvons d'un observateur à l'autre une forte variation, allant jusqu'à 10 cm, dans l'estimation de la distance qui sépare cette ligne de la ligne médiane. Cette variation est plus forte quand il s'agit de sujets obèses que pour ceux de configuration normale (p = 0,004). Elle est la même chez les spécialistes et les internes. On discute de l'insuffisance de la LMC comme repère.

The midclavicular line (MCL) is the standard reference point for clinical assessment of liver size and localization of the cardiac apex. However, in 1968 Rytand[1] reviewed several anatomy texts and physical diagnosis manuals and noted some uncertainty about the location of the MCL. A point of confusion was the tendency to assume that the MCL and the mamillary line were synonymous, when in fact the latter runs parallel to the midline through the nipple, while the former may or may not pass through the nipple, depending on the anatomy of the person examined. This particular mistake is still found in medical dictionaries,[2,3] but a sampling of physical diagnosis manuals of various vintages[4-8] suggests that most authors define the MCL as a line that takes its origin from a point halfway between the sternoclavicular and acromioclavicular joints (i.e., the midpoint of the clavicle) and follows a perpendicular course from that reference point. Since the clavicle itself may not be perfectly horizontal, some authors specify that the MCL runs parallel to the anatomic midline or the midsternal line.

One obvious difficulty with this reference point is that there is no generally applied "gold standard" to validate a clinician's determination of the position of the MCL. Hence, the accuracy of clinical MCL estimates is uncertain. Lack of a reference standard also predisposes indirectly to imprecision: if each clinician assumes that his or her MCL estimate is an accurate reflection of the "true" MCL, interobserver variation may simply be ignored.

We therefore hypothesized that there could be considerable variation in independent estimates of the MCL position, that this variation might be more pronounced in an obese subject, and that the greater the vertical distance from the clavicle, the greater the variation.

Methods

We recruited three volunteers, two of virtually identical build ("normal", weight 78 kg, height 182 cm) and one who was heavier ("obese", weight 102 kg, height 177 cm). Twenty medical consultants and house staff were asked to independently estimate, at two sessions, the location of the right MCL in an obese subject and a subject of normal build. At the first session a tape measure was affixed on each of the two subjects to run horizontally across the right hemithorax starting at the junction of the fifth rib and the sternum in the region where the upper border of the liver might be expected to lie. At the second session the procedure was done below the costal margin to approximate the area of palpation or percussion of the lower edge of the liver. Each volunteer of normal build served as a subject in only one of the two sessions.

To avoid giving visual clues with the tape measure readings, the tapes were positioned to run from the middle of the sternum or midline of the

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abdomen around to the back, and no zero point was shown. Each examiner was simply asked to estimate where the MCL intersected the tape measure and to designate this point on the tape, to the nearest 0.5 cm. For example, in the initial experiment with the obese subject, the most medial number showing on the tape was 52 cm, the midsternal line lay at 50.5 cm, and the examiners picked points ranging from 37 to 47 cm on the tape as the location of the MCL.

In the absence of a standard method for locating the MCL, a "best estimate" for each subject was made as follows. The acromio- and sternoclavicular joints were palpated. The distance between them along a straight line was measured, and the midpoint of the line was marked. The distance from that midpoint to the midsternal line was then measured.

Statistical tests for relative importance of body type and level on the thorax or abdomen as sources of variation in MCL estimates were performed with F ratios. A one-tailed distribution was assumed, given the hypothesis that if there was variation, it would be greater with obesity and the lower level. The p values from standard F tables were halved to allow for the fact that the tables are set up for a two-tailed distribution. Since two tests were performed, a Bonferroni-type correction was applied to set the significance level for each test at 0.025.

F ratios were also calculated to assess the hypothesis that interobserver variation would be identical for consultants and house staff. A two-tailed distribution was assumed. Since four tests were performed, the corrected significance level was 0.0125.

Results

To estimate the location of the MCL, some examiners palpated to find the ends of the clavicle, estimated its midpoint visually and then drew a finger down the chest wall perpendicular to the clavicle to the tape measure. Others studied the subject's torso and abdomen, then picked a point on the tape. None used a measuring device. The range in estimates was substantial, and the mean of the 20 estimates was closer to the midsternal line in each case than was our best estimate (Table I).

Table I — Estimates of the location of the midclavicular line (MCL) by 20 medical consultants and house staff

Variable	Distance of MCL from midline, cm	
	At fifth rib	Below costal margin
Obese subject		
Mean (and standard deviation [SD])	8.5 (1.99)	8.5 (2.46)
Range	3.5–13.5	5.0–14.0
Best estimate	10.0	10.0
Subjects of normal build (n = 2)		
Mean (and SD)	7.9 (1.54)	8.6 (1.46)
Range	5.5–12.0	6.0–11.5
Best estimate	10.5	11.5

Variability in MCL estimates was greater for the obese subject (obese versus normal build: $F = 2.234$ [degrees of freedom 38,38], $p = 0.004$). The variability was not affected by the level on the thorax or abdomen where the MCL was estimated.

Examiner status was also tested as a source of variation. No significant difference in variation was found between consultants and house staff.

In the two subjects of normal build, to check the accuracy of the best estimate and to confirm the difference in MCL position despite their identical height and weight we halved the length of the clavicle as determined by radiography and added the measured distance from the sternoclavicular joint to the midsternal line. The distances from the MCL to the midline in the two subjects were 10.25 and 11.45 cm. These figures corresponded closely to the best estimates of 10.5 and 11.5 cm respectively.

Discussion

It is intuitively obvious that the distance from the MCL to the anatomic midline depends on the size of the patient and the configuration of the thorax. Indeed, the convenience of the MCL has rested on the fact that it appears to serve as a self-adjusting landmark for each patient and therefore takes account of differences in size and build. However, our results suggest that clinical estimates of the location of the MCL are neither precise nor accurate.

For practical purposes, imprecision is of greater concern than inaccuracy in MCL estimates. So long as clinicians agree about the location of the MCL, it can still serve as a landmark in physical examination, even if the "clinical" MCL and the "true" MCL differ. The considerable imprecision shown in our experiment may be an underestimate, since the clinicians knew they were under observation and took special pains to estimate the position of the MCL. For example, in our experience clinicians do not routinely attempt to determine the position of the MCL by actual palpation of the clavicle.

As expected, the estimates of MCL position in the obese subject were less precise (albeit more accurate on average) than those in the subjects of normal build. We expect that a similar increase in interobserver variation could be demonstrated in a nonobese woman with pendulous breasts.

Our best estimates of the MCL location were lateral to the mean estimates of the 20 clinicians. We hypothesize that this discrepancy resulted because visual examination without actual palpation or measurement of the clavicle tends to give an underestimate of its length, particularly in broad-shouldered people. On the other hand, the

radiologic confirmation of the best estimates in the two subjects of normal build suggests that a painstaking approach can yield an accurate estimate of the MCL position. Further experimentation is needed to determine whether this greater accuracy is associated with less interobserver variation.

Excellent cardiologic texts continue to state or imply that palpation of the apical impulse lateral to the left MCL implies cardiomegaly.[9-11] Indeed, in clinical parlance, one commonly hears a normal apex beat described as being "at the fifth rib in the MCL". There is no prima facie reason to believe that our results from the fifth rib level on the right should not reflect the precision and accuracy of corresponding MCL assessments on the left. The magnitude of interobserver variation is clearly such that what one clinician considers cardiomegaly may be viewed as the normal apex position by another.

Constant[12] has suggested that the mid-left thorax at the fourth or fifth interspace be used in preference to the MCL; cardiomegaly would be present if the apical impulse were palpable or visible 2 cm lateral to this midthoracic line. However, midthoracic line estimates are liable to suffer from the same imprecision as that demonstrated for MCL estimates.

On the other hand, Constant has also suggested that in an adult the normal ventricular impulse should not be more than 10 cm from the midline of the sternum, and Bates[13] supports this by defining the normal apex beat as being in the fifth interspace, 7 to 9 cm from the midsternal line. Although our findings provide evidence for those who prefer measurements from the midline rather than from reference points such as the MCL or midthoracic line, we have not seen a study validating the norms suggested by Constant and Bates. Measurement norms could easily prove misleading in extremely large or small adults. Furthermore, a standardized technique would have to be established. For example, Bates recommends measuring along the straight line tangent to the curve of the thorax, Constant does not specify a technique, and most clinicians that we have observed simply bend a flexible ruler around the chest wall to the cardiac apex beat. We therefore suggest that except in cases of gross displacement of the cardiac apex, in which interclinician consensus is easily obtained, clinical assessments of cardiomegaly are unreliable.

The situation with respect to clinical estimates of liver size is even more complex, for there is controversy over both the ideal method of assessment and the range of normal values.[14-21] Generally, measurement of liver span is made in the MCL, but the examiner may use light or heavy percussion and may locate the lower edge of the liver either by percussion or by palpation. Because of the asymmetric form of the liver, interobserver disagreement on liver size due to differing methods may be further magnified if clinicians make differing estimates of the location of the MCL. Attention to this problem as a secondary source of variability in clinical assessement of liver size may assist those who attempt to develop reliable approaches to the physical diagnosis of hepatomegaly.

Greater precision in clinical localization of the MCL would be helpful to the art and science of physical examination. At present, the MCL is a wandering landmark with limitations as a reference point for clinical purposes.

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References

1. Rytand DA: The midclavicular line: Where is it? *Ann Intern Med* 1968; 69: 329-330
2. *Stedman's Medical Dictionary*, 22nd ed, Williams & Wilkins, Baltimore, Md, 1973: 714
3. *Dorland's Illustrated Medical Dictionary*, 26th ed, Saunders, Philadelphia, 1981: 746
4. Bouchier IAD, Morris JS: *Clinical Skills: a System of Clinical Examination*, Saunders, Philadelphia, 1982: 77
5. Prior JA, Silberstein JS: *Physical Diagnosis. The History and Examination of the Patient*, Mosby, St. Louis, Mo, 1963: 174
6. Delp MH, Manning RT: *Major's Physical Diagnosis*, Saunders, Toronto, 1968: 89
7. Hochstein E, Rubin AL: *Physical Diagnosis: a Textbook and Workbook in Methods of Clinical Examination*, McGraw, New York, 1964: 99
8. Bates B: *A Guide to Physical Examination*, 3rd ed, Lippincott, Philadelphia, 1983: 128
9. Braunwald E (ed): *Heart Disease: a Textbook of Cardiovascular Medicine*, 2nd ed, vol 1, Saunders, Philadelphia, 1984: 26-27
10. Fowler NO (ed): *Cardiac Diagnosis and Treatment*, Har-Row, New York, 1976: 205
11. Craige E: Inspection and palpation of the precordium. In Hurst JW (ed): *The Heart: Arteries and Veins*, 5th ed, McGraw, New York, 1982: 199
12. Constant J: *Bedside Cardiology*, 2nd ed, Little, Boston, 1976: 104-105
13. Bates B: *A Guide to Physical Examination*, 3rd ed, Lippincott, Philadelphia, 1983: 158
14. Peternel WW, Schaefer JW, Schiff L: Clinical evaluation of liver size and hepatic scintiscan. *Am J Dig Dis* 1966; 11: 346-350
15. Castell DO, O'Brien KD, Muench H et al: Estimation of liver size by percussion in normal individuals. *Ann Intern Med* 1969; 70: 1183-1189
16. Blendis LM, McNeilly WJ, Sheppard L et al: Observer variation in the clinical and radiological assessment of hepatosplenomegaly. *Br Med J* 1970; 1: 727-730
17. Sullivan S, Krasner N, Williams R: The clinical estimation of liver size: a comparison of techniques and an analysis of the source of error. *Br Med J* 1976; 2: 1042-1043
18. Sapira JD, Williamson DL: How big is the normal liver? *Arch Intern Med* 1979; 139: 971-973
19. Castell DO: How big is the normal liver, indeed! Ibid: 968-969
20. Sherlock S, Summerfield JA: *Color Atlas of Liver Disease*, Year Bk Med, Chicago, 1979: 9
21. Malchow-Moller A, Rasumussen SN, Jensen AM et al: Clinical estimation of liver size. *Dan Med Bull* 1984; 31: 63-67